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Data for Model Building and Validation for Non-lethal Weapons and Crowd Management: Initial Efforts

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14. ABSTRACT
There have been many efforts to create a simulation of crowd behavior using existing platforms. However, all efforts to date have been fatally flawed by the lack of crowd data for building the model, and the lack of methods and means for verification and validation of the crowd simulation. In the past two years the Target Behavioral Response Laboratory has collected multilevel crowd data and information on 200 individuals' behaviors in 15 crowd experimental runs. The basic paradigm is a rock throwing crowd facing a control force wielding a variety of simulated non-lethal weapons, including simulated hand-to-hand combat and stand-off weapons. This presentation demonstrates the theory of how to leverage this large archive of data, first to build the model, then to verify and validate crowd simulation.

15. SUBJECT TERMS
non-lethal weapons, crowd, modeling and simulation, data, empirical modeling, mathematical modeling, computational modeling, validation, verification, laboratory testing, motion capture, crowd metrics, Lewin, Field Theory

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Methods

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Gather empirical data on

real people and

real groups in tactically relevant situations

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Test Setup

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Method

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- 12-19 individuals
- Manipulated type of weapon and the ROE
- “Deny access into/out of an area to individuals” JNLE/CBA)
- Recorded spatial data

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Data Measurement

- Vicon V8i system
- 24 cameras
- 120 fps
- Optical tracking of retro reflective markers (ø14mm)
- Marker error <10mm
- Subjects
  - Unique Helmets
  - XYZ location + 3DOF orientation of head
- Control Force
  - Head & Torso
  - Capability for weapon

Courtesy Vicon

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Crowd Studies: Motivation & Behavioral Manipulations

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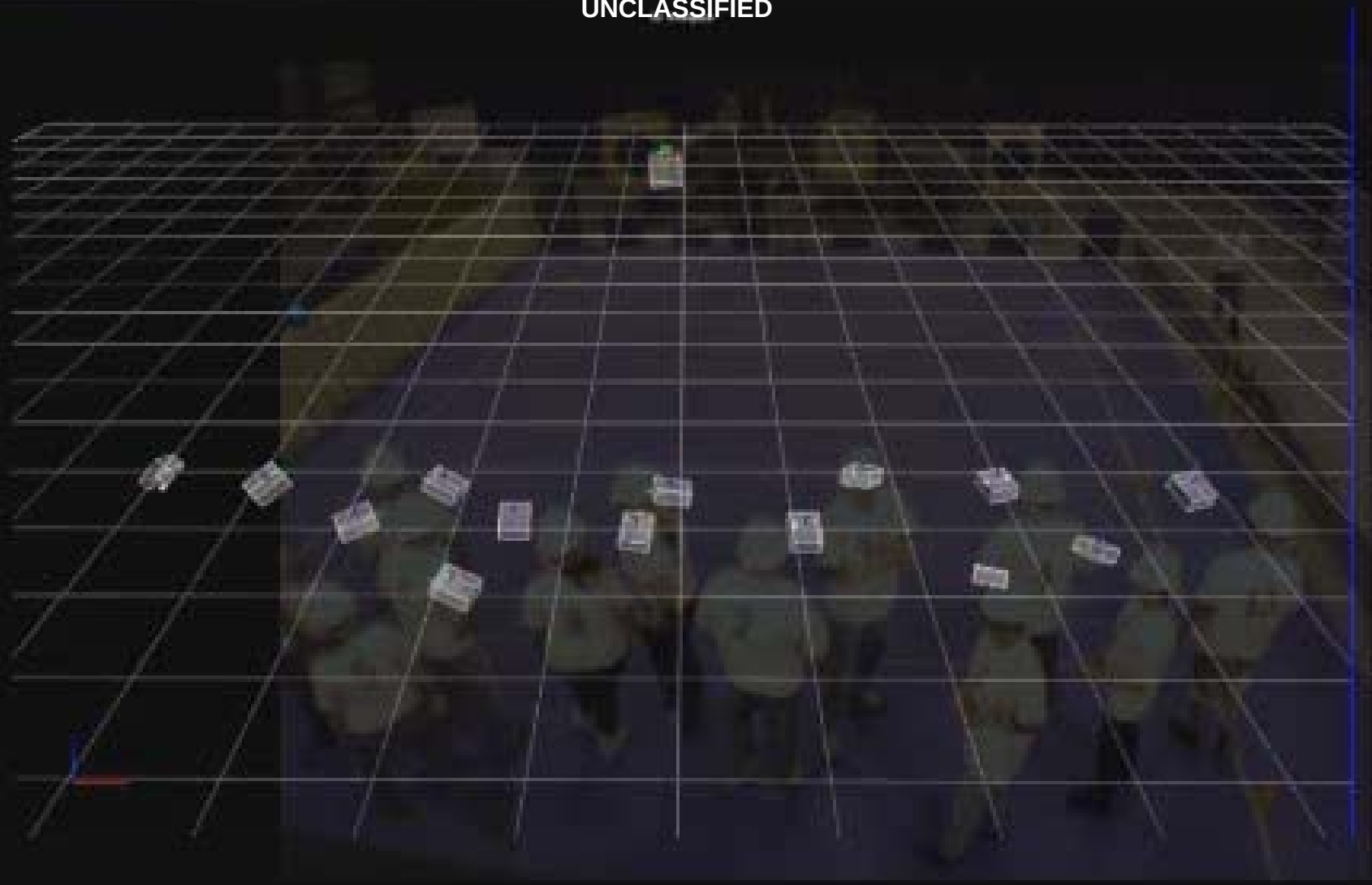

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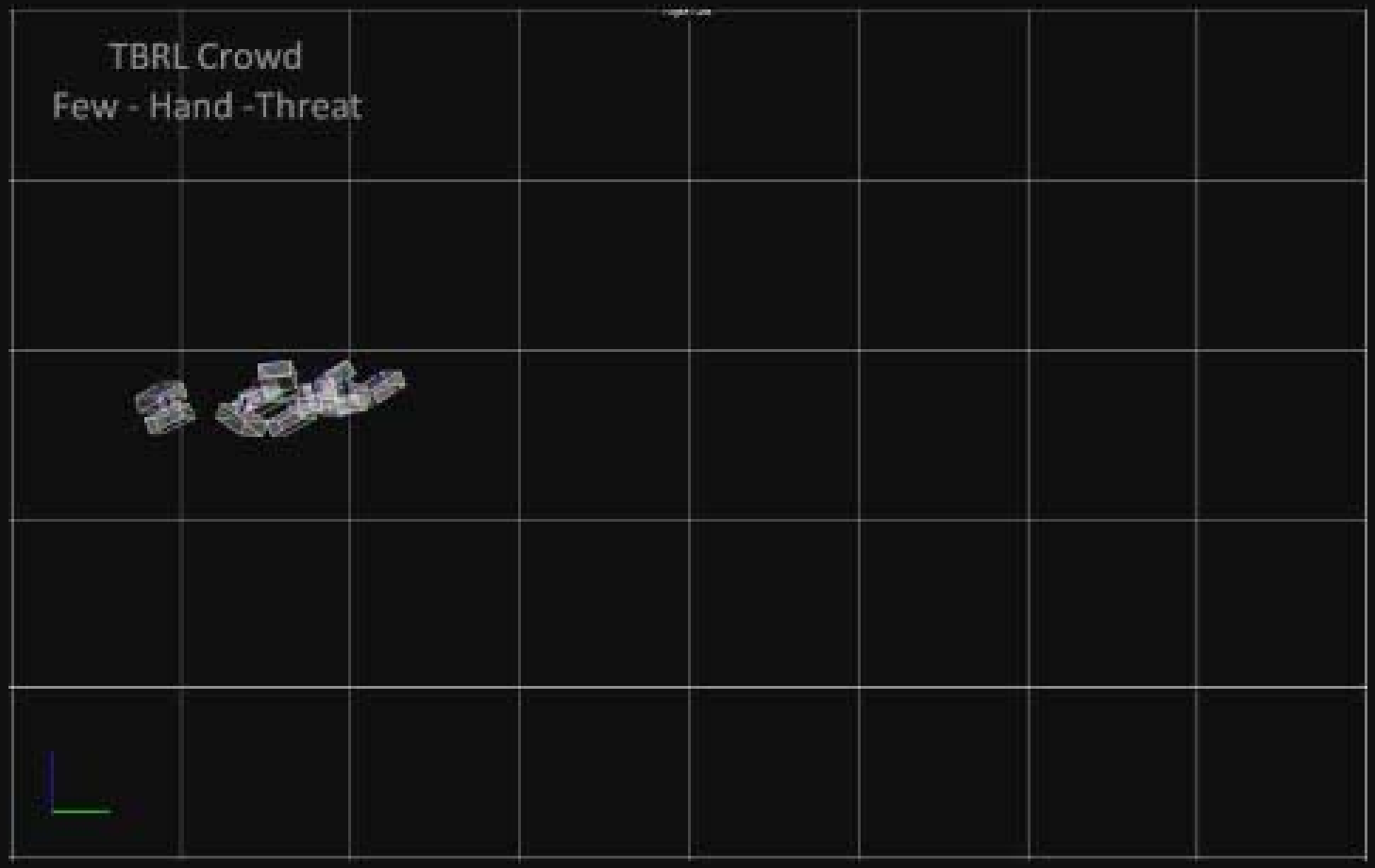
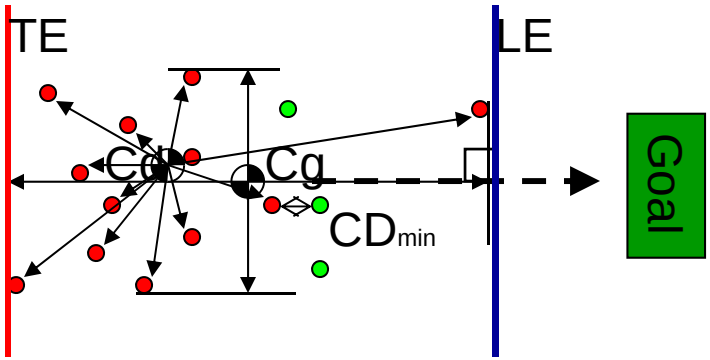
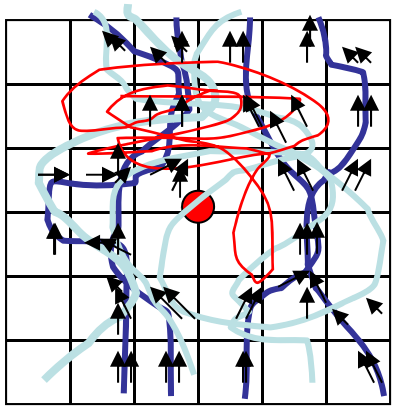
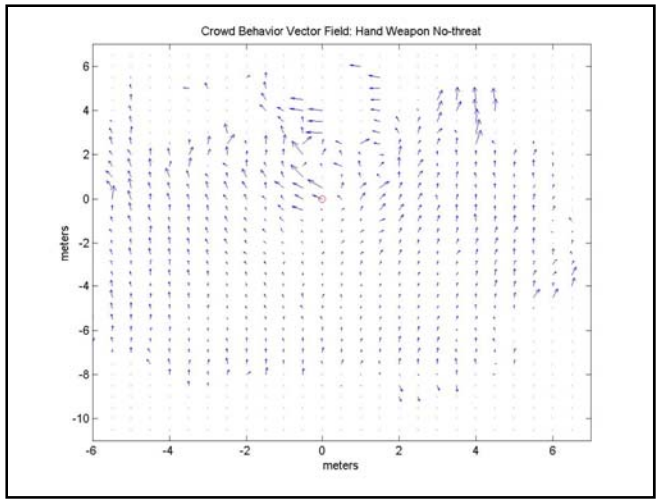
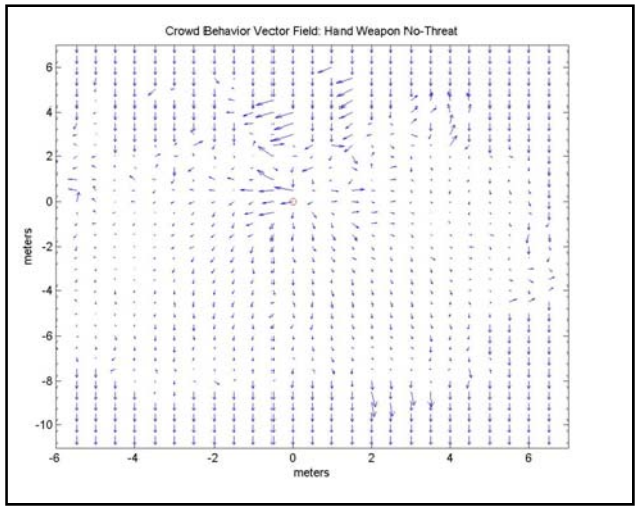

TBRL Crowd
Few - Hand -Threat

Crowd Metrics









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Metrics for Weapon Performance

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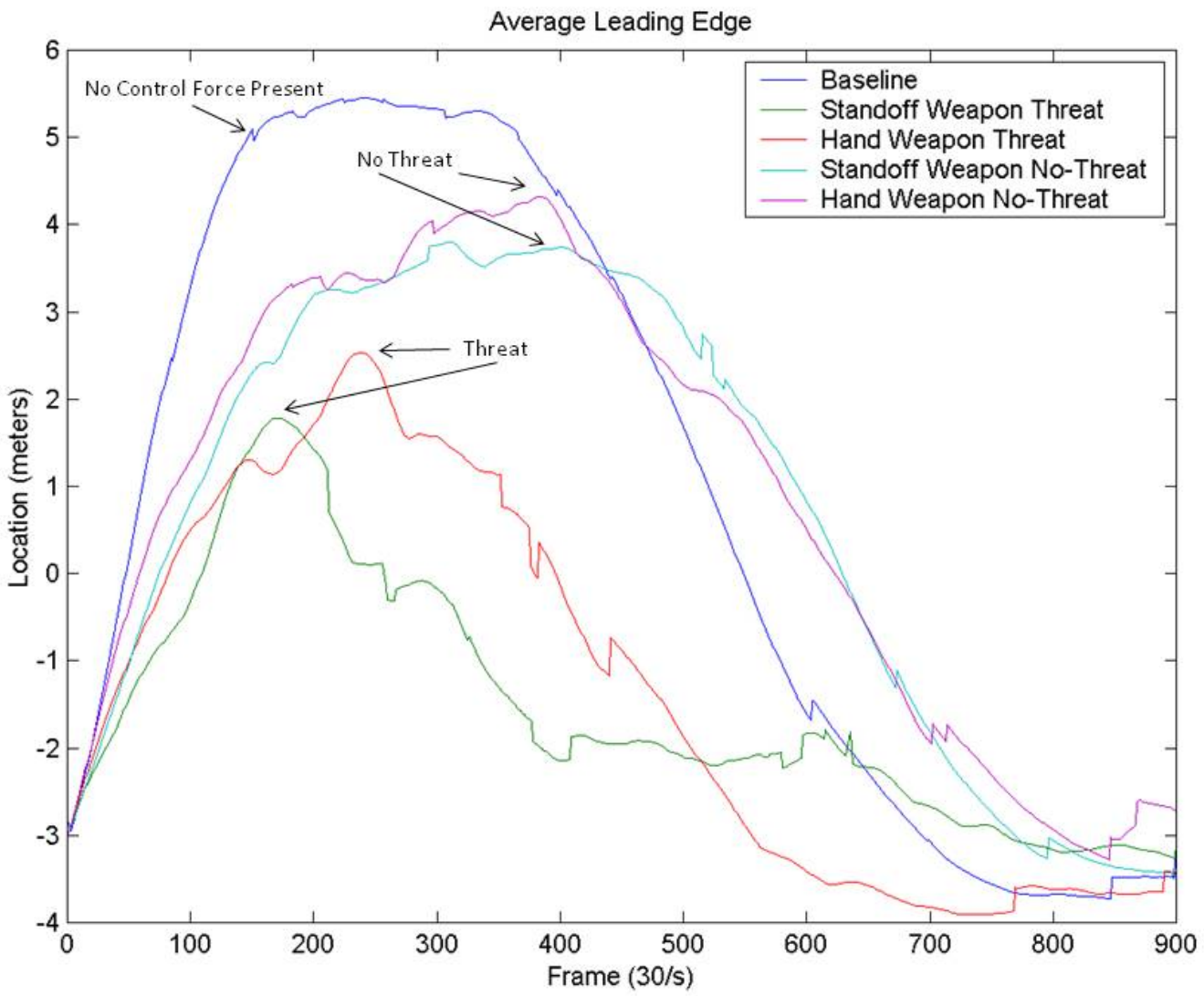

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Crowd Metrics for Effectiveness

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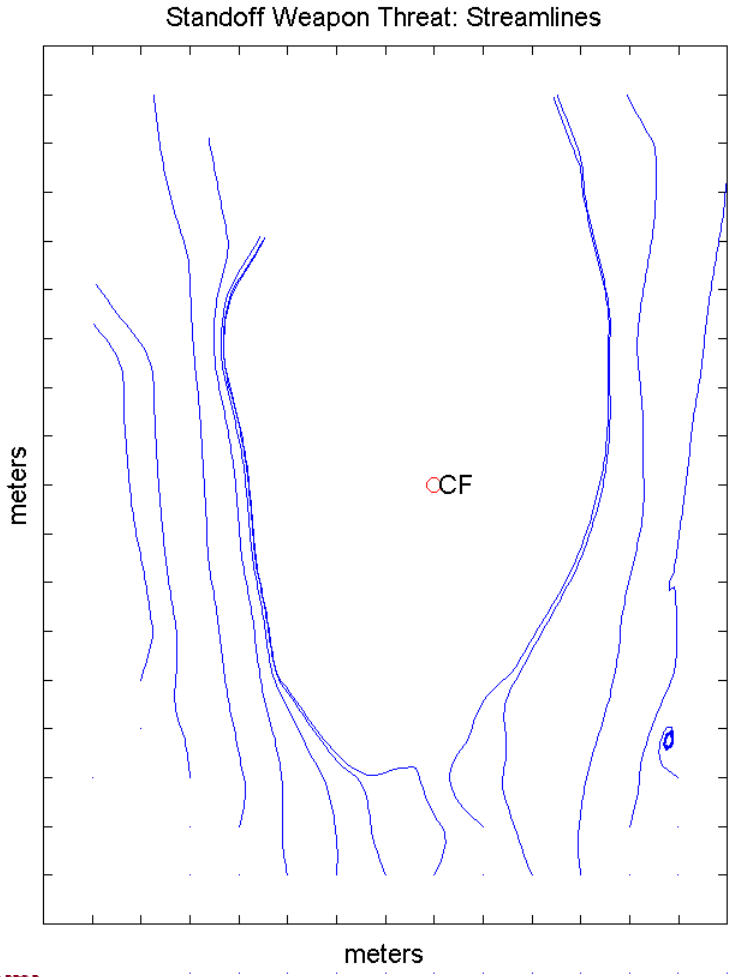

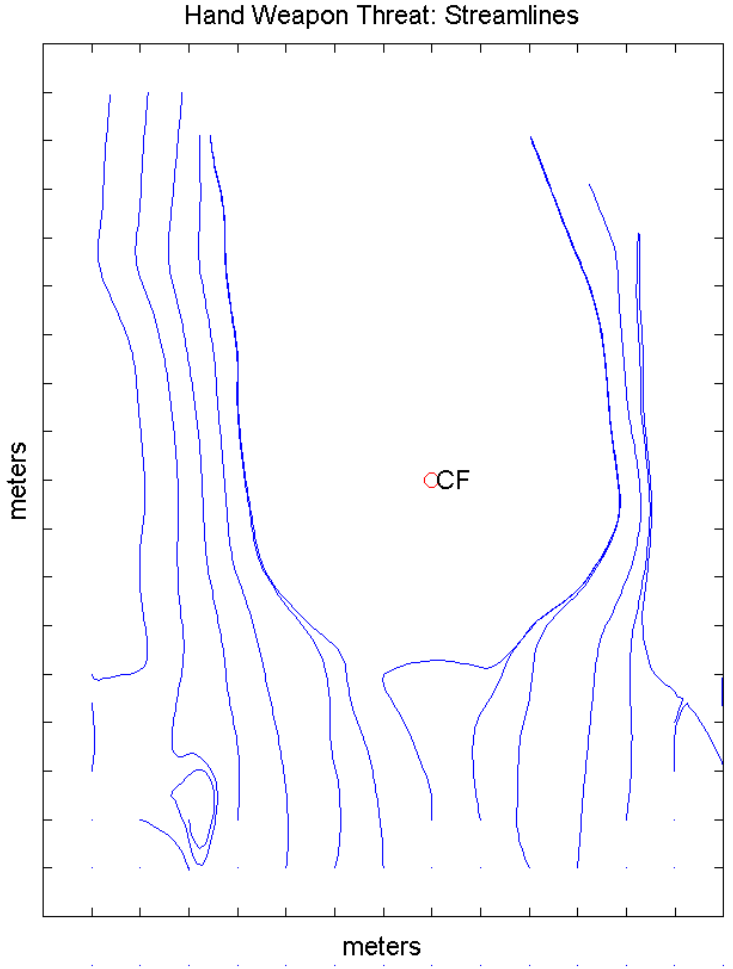

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Modeling Building

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- Quantitative Crowd Metrics allow algorithms to be made
- Algorithms can be used for to build models
- Output and Predictions of applications can be compared to data recorded in lab
- Visualization alone is helpful

Using Data to Build Models

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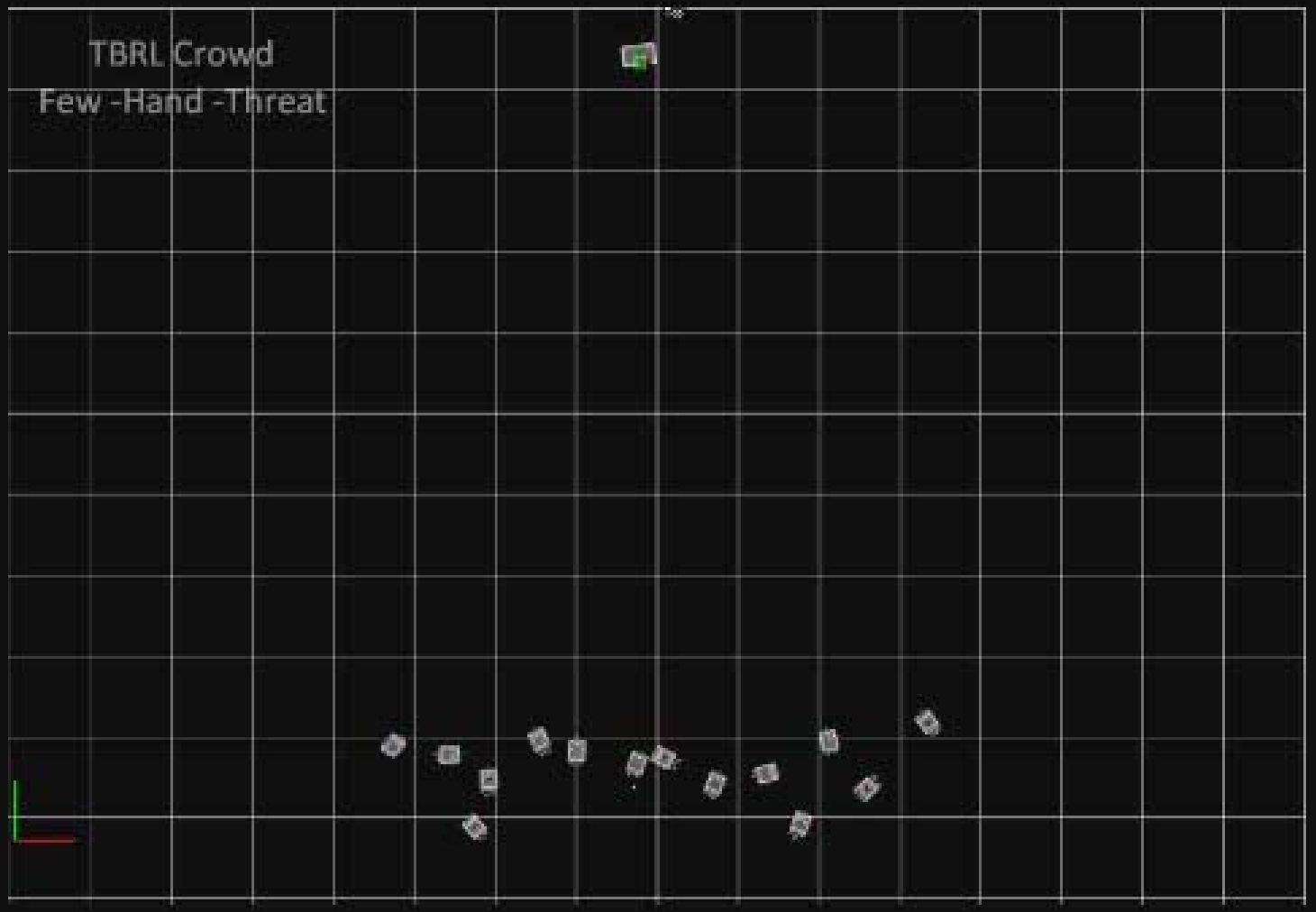
- Comparison of VICON data with computer simulation with same parameters
- MAICE Station™

  Crowd Modeling Application Version 1

  Southwest Research Institute

  www.tspi.swri.org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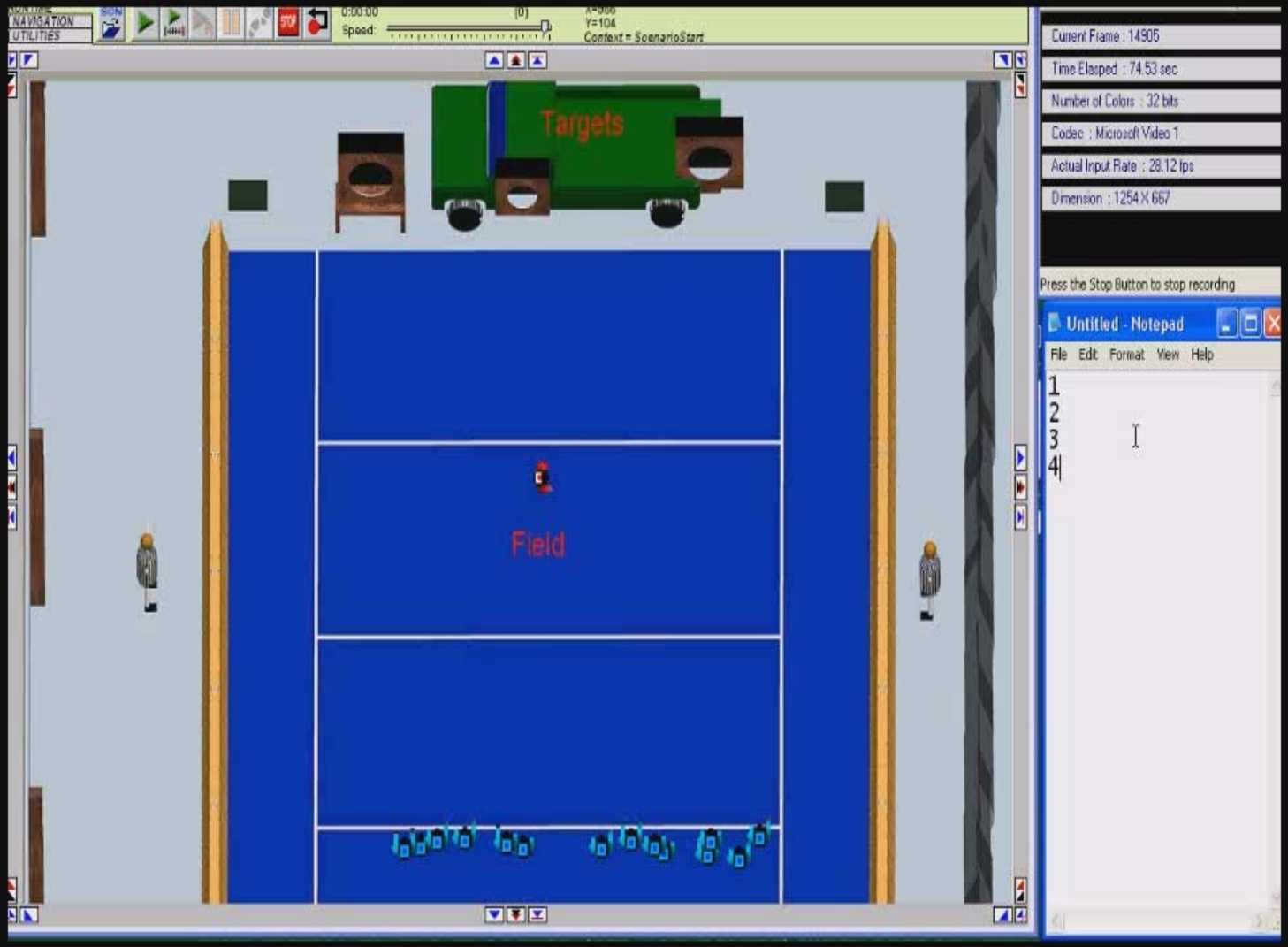
Few -Hand -Threat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Critical Elements for Data Feed into Modeling Efforts

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- Common Conceptualization of Crowd Behaviors
  - *Lewinian Field Theory*
- Common Metrics
- Common Data Formats
- Common Inputs
- Common Outputs
- Common Statistical Analyses

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Using Data for Model Validation

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- Build model around a scenario with one level of a parameter using real human data
- Run model with a different level of a parameter and record output metrics and predictions
  - Real human data must exist at this level of the parameter
- Compare output of model to analyses of laboratory data of real humans

Model Validation: Examples

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Build Model On	Validate Against
• One Control Force	• Three Control Force
• Hand-to-hand Combat Weapon	• Stand-off Weapon
• 10 in crowd	• 20 in crowd

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Comparison of Data and Output

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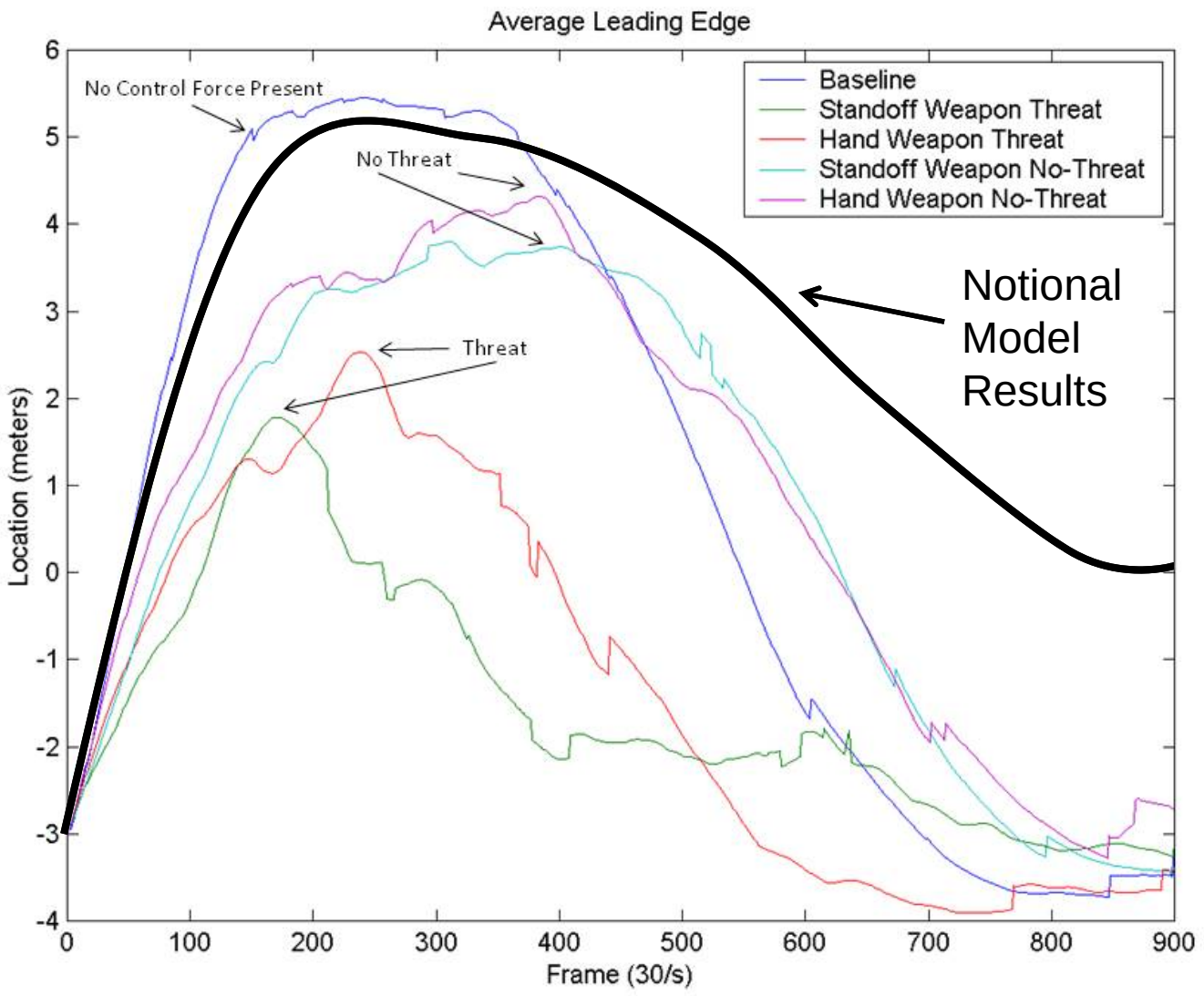

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- Interoperability between model application and data
- Interoperability between physical laboratory and environmental simulations
  - Build scenario to match lab
  - Build lab to match scenario

Standards in VV&A of Human Behavior M&S

- Provides a method for validation of models against real human behavior
- Sets the stage for development of standards for data incorporation
- Sets the stage for development of standards for validation of models by data

Questions?